

and when $dV/dx = 0$,

$$\log x = \frac{5x^2 + 4x + 1}{10x^2 + 4x}.$$

This will be satisfied by making x somewhat less than 1.9, so that in this case the ratio of the diameters of the drums would be a little less and very close to the ratio found for the pulleys.

In order to illustrate the foregoing problems a model of a train of pulleys and another of a train of drums made of brass were constructed by Mr. Yates. In the train of pulleys all the large ones are 1.9 inches in diameter, and all the small are 1 inch. Each of the former weighs 2.61 oz., and each of the latter 1.058 oz.; as there are five pairs their total weight is 18.340 oz., while they give a velocity ratio of $(1.9)^5 = 24.761$, or a little more than $24\frac{3}{4}$.

The train of drums consists of large ones with diameters of 2.55 inches and small of 1 inch, the hoops are in all 0.5 inch in breadth, and the spokes are half the volume of a complete disk. The weights of the large drums are each 3.386 oz., of the small 0.811 oz.

There are four pairs of drums, and their total weight is 16.788 oz., or little more than 1 lb.

The velocity ratio of this train is $(51/20)^4 = 42.2825$, or a little more than $42\frac{1}{4}$.

II. "On the Relation between Tropical and Extra-Tropical Cyclones." By Hon. RALPH ABERCROMBY, F.R. Met. Soc. Communicated by R. H. SCOTT, M.A., F.R.S. Received February 7, 1887.

(Abstract.)

The conclusions as to the relation of tropical to extra-tropical cyclones which the author has derived from the researches of which this paper gives an account, may be stated thus:—

All cyclones have a tendency to assume an oval form; the longer diameter may lie in any direction, but has a decided tendency to range itself nearly in a line with the direction of propagation.

The centre of the cyclone is almost invariably pressed toward one or other end of the longer diameter, but the displacement may vary during the course of the same depression.

Tropical hurricanes are usually of much smaller dimensions than extra-tropical cyclones; but the central depression is much steeper, and more pronounced in the former than in the latter.

Tropical cyclones have less tendency to split into two, or to develop secondaries, than those in higher latitudes.

A typhoon which has come from the tropics can combine with a

cyclone that has been formed outside the tropics, and form a single new, and perhaps more intense, depression.

No cyclone is an isolated phenomenon; it is always related to the general distribution of pressure in the latitudes where it is generated.

An area of excessive pressure, with unusually fine weather, precedes most cyclones. Though the nature and origin of this high barometer is very obscure, the general character of the formation, and the weather associated with it, appear to be the same everywhere.

In all latitudes a cyclone which has been generated at sea appears to have a reluctance to traverse a land area, and usually breaks up when it crosses a coast line.

After the passage of a cyclone in any part of the world, there is a remarkable tendency for another to follow very soon, almost along the same track.

The velocity of propagation of tropical cyclones is always small; and the average greatly less than that of European depressions.

There is much less difference in the temperature and humidity before and after a tropical cyclone than in higher latitudes. The quality of the heat in front is always distressing in every part of the world.

The wind rotates counter-clockwise round every cyclone in the Northern Hemisphere, and everywhere as an ingoing spiral. The amount of incurvature for the same quadrant may vary during the course of the same cyclone; but in most tropical hurricanes the incurvature is least in front, and greatest in rear; whereas in England the greatest incurvature is usually found in the right front. Some observers think that broadly speaking the incurvature of the wind decreases as we recede from the Equator.

The velocity of the wind always increases as we approach the centre in a tropical cyclone; whereas in higher latitudes the strongest winds and steepest gradients are often some way from the centre. In this peculiarity tropical cyclones approximate more to the type of a tornado; but the author does not think that a cyclone is only a highly developed whirlwind, as there are no transitional forms of rotating air.

The general circulation of a cyclone, as shown by the motion of the clouds, appears to be the same everywhere.

All over the world, unusual coloration of the sky at sunrise and sunset is observed, not only before the barometer has begun to fall at any place, but before the existence of any depression can be traced in the neighbourhood.

Cirrus appears all round the cloud area of a tropical cyclone, instead of only round the front semicircle, as in higher latitudes. The stripes of cirrus appear to lie more radially from the centre in the tropics, than tangentially, as indicated by the researches of Ley and Hildebrandsson in England and Sweden respectively.

The general character of the cloud all round the centre is more uniform in than out of the tropics; but still the clouds in rear are always a little harder than those in front.

Everywhere the rain of a cyclone extends farther in front than in rear. Cyclone rain has a specific character, quite different from that of showers or thunderstorms; and this character is more pronounced in tropical than in extra-tropical cyclones.

Thunder or lightning is rarely observed in the heart of any cyclone, and the absence of electrical discharge is a very bad sign of the weather. Thunderstorms are, however, abundantly developed on the outskirts of tropical hurricanes.

Squalls are one of the most characteristic features of a tropical cyclone, where they surround the centre on all sides; whereas in Great Britain, squalls are almost exclusively formed along that portion of the line of the trough which is south of the centre, and in the right rear of the depression. As, however, we find that the front of a British cyclone tends to form squalls when the intensity is very great, the inference seems justifiable that this feature of tropical hurricanes is simply due to their exceptional intensity.

A patch of blue sky, commonly known as the "bull's-eye," is almost universal in the tropics, and apparently unknown in higher latitudes. The author's researches show that in middle latitudes the formation of a "bull's-eye" does not take place when the motion of translation is rapid; but as this blue space is not observed in British cyclones when they are moving slowly, it would appear that a certain intensity of rotation is necessary to develop this phenomenon.

The trough phenomena,—such as a squall, a sudden shift of wind, and change of cloud character and temperature, just as the barometer turns to rise, even far from the centre—which are such a prominent feature in British cyclones, have not been even noticed by many meteorologists in the tropics. The author, however, shows that there are slight indications of these phenomena everywhere; and he has collated their existence and intensity with the velocity of propagation of the whole mass of the cyclone.

Every cyclone has a double symmetry. One set of phenomena, such as the oval shape, the general rotation of the wind, the cloud ring, rain area, and central blue space, are more or less related to a central point.

Another set, such as temperature, humidity, the general character of the clouds, certain shifts of wind, and a particular line of squalls, are more or less related to the front and rear of the line of the trough of a cyclone.

The author's researches show that the first set are strongly marked in the tropics, where the circulating energy of the air is great, and the velocity of propagation small; while the second set are most

prominent in extra-tropical cyclones, where the rotational energy is moderate, and the translational velocity great.

The first set of characteristics may conveniently be classed together as the rotational; the second set as the translational phenomena of a cyclone.

Tropical and extra-tropical cyclones are identical in general character, but differ in certain details, due to latitude, surrounding pressure, and to the relative intensity of rotation or translation.

III. "A Thermal Telephone Transmitter." By Prof. GEORGE FORBES. Communicated by LORD RAYLEIGH, D.C.L., Sec. R.S. Received February 12, 1887.

We have had so much evidence of the sensitiveness of the Bell telephone receiver to the minutest changes of current, that we have ceased to be surprised at any transmitter which responds to the sounds of articulate speech. But, in the instrument now shown, it was so extremely unlikely that sensible variations of current could be produced with sufficient rapidity, that even now there is perhaps some interest attached to the experiment. A wooden cylinder was used closed at one end. A saw cut was made across the diameter of the closed end, making a fine slit. In the slit was stretched a platinum wire, 0.001 inch diameter and 2 inches long, with its ends connected by copper wires through the primary of an induction coil to a battery sufficiently powerful to make the platinum wire red hot. On connecting the secondary circuit with a receiving telephone in a distant room and speaking into the wooden cylinder, the words are reproduced and heard in the telephone. Each vibration of air in the slit cools the platinum wire, diminishing its electrical resistance, and increasing the electric current. The words transmitted are not quite perfect, the higher harmonics being wanting. It requires some attention to make out all the words of a sentence. A brass cylinder instead of the wooden one, and a Wollaston platinum wire of excessive fineness have been used without materially altering the clearness of the articulation. Platinum foil has hitherto given no sound of the voice. The slit in the brass instrument is made of glass to prevent the short-circuiting and destruction of the platinum wire.

Wires from one to three inches in length have been used. The longest ones are best. No distinct articulation is heard if the wire be not red hot. The hotter the wire the better is the articulation. An adjustable slit was tried and the narrow slit gave the best results. Mr. Preece some years ago used the expansion and contraction of a fine platinum wire to act on a diaphragm, and so serve